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THE MEASUREMENT OF ATTENTION IN THE FIELD OF CUTANEOUS SENSATION[1]

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We have recently published a study in the measurement of attention within the field of audition.[2] Since that time we have repeated the work within the field of cutaneous sensation, and it is our purpose in this paper to present these additional and confirmatory results. We do not intend at this time to criticise the methods of dealing with the problem of attention, or to draw theoretical conclusions from our results. At some later date we hope to deal comprehensively with the facts, the methods, and the criticisms of the measurement of attention; but we have wished not to delay unduly the publication of these results.

Methodically, the present study differs in no important respect from its predecessor, except that cutaneous sensation is substituted for auditory, and that the attributive changes are therefore changes of intensity and extent instead of changes of intensity and pitch. For general procedure and details of method the reader is referred to the earlier paper. In general our tables can be understood from the description there given, if substitution of extent for pitch be made. It would be well, then, if the present paper were read with the other at hand.

[1] Presented at the Chicago meeting of the American Psychological Association, December, 1915. The experimental work was done in the psychological laboratory of the University of Oregon in 1913-15.

[2] K. M. Dallenbach, this JOURNAL, XXIV, 1913, 465-507. L. R. Geissler, *ibid.* XX, 1909, 502-529, first used the method for vision.

Observers.—The observers were Mr. E. Good (G), Miss G. Cross (C), and Mr. M. Goodwin (Gn). All three were advanced students in psychology, and had had considerable practice and experience in introspection. They all worked without knowledge of the problem, and they served regularly three hours a week.

METHODS

Preliminary Training in Introspection.—The procedure was practically the same as in the earlier work,[3] except that the interval was shortened (30 to 60 secs.).

Practice was continued for four months. At the end of the third month the scale of degrees of clearness [4] had been worked out by all observers.

Preliminary Practice in Observation under the Normal Conditions of the Main Experiments.—Our stimulus was a faradic current from a Harvard inductorium. Four large Edison-Lalande cells (E. M. F. 0.85), arranged in series, were used to actuate the primary coil. The strength of the primary current was practically constant, for at the beginning of every experimental hour we reduced the current, by the aid of a small rheostat, to 25 amperes. Measurement was made by a small ammeter shunted into the circuit. There was a slight reduction in the current as the hour and the experimental work progressed; but since only 4-6 experiments were conducted during the hour, and since an experiment lasted only 20 seconds, the reduction was very slight and the current might be regarded as constant. In any case, as Martin [5] has shown, a slight variation in the strength of the primary current will cause no appreciable change in the strength of the secondary.

The intensity of the secondary current was controlled by a shift in the position of the secondary coil. The extensity of the stimulation was controlled by a three-way switch which permitted us to shunt the current to any one of three electrodes which served as stimulus.

The common electrode was placed at the back of the neck over the *vertebra prominens* and the other, the stimulus (three concentric copper rings) upon the dorsal side of the left forearm about 10 cm. below the elbow joint. The areas stimulated by the three electrodes were all supraliminally different. This was determined empirically and separately for each observer, and a value was taken which was well above the limens as follows: the area of the smallest electrode was 7.06 sq. mm.; that of the medium, 94.25 sq. mm.; and that of the largest, 188.69 sq. mm. The smallest electrode was round, 3 mm. in diameter; the medium was a ring 2 mm. in width, with an inside diameter of 13 mm.; the largest was likewise a ring 2 mm. in width, with an inside diameter of 28 mm. The medium was insulated from the other two by sealing wax. The cutaneous sensations were localized at the arm. At high intensities the current was also perceived at the neck: a limit which, once determined, we never approached. Owing to the difference in areas stimulated, and consequently in the amount of resistance offered to the current, the sensations from the three electrodes were not of the same intensity. Therefore resistance was added to these circuits such that the intensity of the cutaneous sensations was equal for equal intensities of the current. The amount of resistance to be added was

[3] Pp. 467f. [4] P. 468.

[5] E. G. Martin, *Am. J. of Physiology*, XXII, 1908, 61-74; 116-132.

different for every observer, and individual rheostats were accordingly provided.[6]

The changes in the intensity of the cutaneous sensations were also supraliminally different, extending in every case through two just noticeable differences. These steps were computed separately for every observer by the method of Just Noticeable Differences.

The three-way switch, by which the current was shifted to the different arm-poles, and the secondary coil of the inductorium were fitted with large scales and long moving arms, which permitted us to make gross movements in their adjustment.

The observer's left arm and hand, dorsal side up, were secured in a plaster cast which prohibited all movement, whether voluntary or involuntary.[7] The electrode was held in position, 10 cm. below the elbow joint, by an elastic band, which insured not only that the electrode would be returned to the same area from experiment to experiment, but also that it would be held on the arm at a constant pressure.

The pressure, including the weight of the electrode, was 200 grams for G; 196 for C; and 199 for Gn. The area stimulated was frequently shaved, and before every experiment was bathed in a concentrated salt solution.

The electrode at the *vertebra prominens* was composed of a nickel-plated brass plate 3 cm. by 6 cm. It was covered by a felt pad 1 cm. in thickness. This pad was thoroughly saturated at the beginning of every hour with a concentrated solution of salt. This electrode was secured in position by an elastic tape encircling the neck.

The observer was seated at a table in a dark room with his left arm secured in the manner just mentioned, and his right hand resting upon a silent electrical key; and the experimenter was placed with the induction coil and the control apparatus in a room near by. The observer was, moreover, enclosed in a muslin booth, illuminated from above by an electric light controlled from the experimenter's desk. The experiments were conducted in dark-adaptation, and the light was turned on at the end of an experiment so that the observer could write his introspection and bathe his arm, while the experimenter was preparing the apparatus for the next experiment.

The graphic records of times were obtained in the same manner as in the earlier experiment.[8]

The *instructions* were those of the previous experiment, adapted for the altered conditions.[9]

The time of an experiment was decreased to 20 secs. in order to increase the accuracy of report.

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[6] My thanks are due to Prof. Wm. P. Boynton, of the department of physics at the University of Oregon, who aided me in standardizing my apparatus, and who suggested the lead-pencil rheostats that were used to equalize the intensity of the cutaneous sensations; and to Mr. Wm. H. Kiler, of the engineering department of the Southern Pacific Railroad, who aided me in constructing and setting up the apparatus.

[7] We at first attempted to work with the volar side of the arm, but soon abandoned it for the dorsal side. The change was imperative because of the great number of motor centers on the volar side. We found that it was impossible to stimulate any area upon this side of the arm, within the necessary limits of our experiment, without causing some muscular contraction. This distraction was eliminated by shifting the electrode to the other surface.

[8] P. 469. [9] P. 469.

The detailed *arrangement of series* followed the general principles laid down in our first paper.[10] There were 76 series in all. These involved 104 changes of extensity and 104 changes of intensity. Half of each were changes in the direction of greater, and half in the direction of smaller.

In this practice work G performed 40 experiments; C, 68; and Gn, 58. The work covered a period of three months: April, May, part of October, and part of November, 1914.

Single Task Method.

Six distractors were employed:

1. Flicker (8 rhythms and 10 intensities).
2. Buzzer (3 intensities).
3. Electric bell (3 intensities).
4. Metronome (4 rates: 60, 90, 120, and 150).
5. Flicker and metronome (with above variations).
6. Phonograph.

The flicker was produced by means of the electric bulb which was used to light the booth in which the observer worked. The illuminating current was made and broken very rapidly by a device connected with a small motor. Ten variations of intensity from very weak to the full intensity of the light were given by a rheostat. Eight cadences were used, which varied from regular, slow, and rapid, to discontinuous and jerky.[11]

Different intensities of buzzer and bell were obtained by varying the strength of the current.

The phonograph stood upon the experimenter's desk; the sound was conveyed to the observer by a speaking tube.

Instructions and *series* were practically identical with those for the Single Task Method in the earlier experiment,[12] except for the changed conditions and the reduction of the period to 20 secs.

Every observer performed 76 experiments under this method, all during the winter of 1915.

As in our other experiments,[13] only the higher degrees of attention occurred. Hence it was necessary to supplement the results by those of the Double Task Method.

Double Task Method.

The second task was that of continuous addition or subtraction. The procedure was in general that of the earlier paper.[14] Three 'difficulties' were used, and the numbers were so chosen as to give greater uniformity within each 'difficulty' and a greater difference between them. The numbers were presented auditorily by an Edison dictaphone connected with the speaking tube which led to the observer's booth.

The *instruction* was essentially that of the first experiment, except that the questionary was omitted.[15]

The experiments were made in the last part of May and first part of June, 1915. Every observer performed 60 experiments: a reduction from the complete series of 76 necessitated by the ending of the term.

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[10] *Cf.* pp. 470f.

[11] The method proved less satisfactory than that with the episcotister, *op. cit.* 472f., but was necessitated by the lack of a silent motor.

[12] P. 474. [13] P. 490. [14] P. 491. [15] P. 492.

RESULTS

Table I shows for the Single Task Method the degrees of clearness given in the various reports in relation to the accuracy of the report and the kind and direction of change. It is in every way analogous to Table I of our earlier paper.[16]

Table II shows the same results for the Double Task Method. It may be understood by reference to Table X of the first paper.[17]

Tables I and II give only the number of cases occurring under their rubrics. A comparison of the data is more clearly afforded by Tables III and IV. These tables are the analogues of Tables II[18] and XI[19] in the first paper.

The tables bear out in every detail the findings of our first study. The higher degrees of clearness favor right cases and subjective reports. The Double Task Method brings a greater range of degrees of clearness.

The weighted summaries of Tables V and VI are obtained from the summaries of Tables III and IV in accordance with the method of weighting laid down in our previous study.[20] Tables V and VI are analogous to Tables III[21] and XII[22] of that study. As in our former work, we see that the crests of the curves of the right judgments lie, in the case of either method, above the crests of the curves of the wrong judgments. We have thus reestablished the relation between introspectively distinguished variations of clearness and accuracy of work performed.

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[16] Pp. 474ff.
[17] Pp. 494ff.
[18] Pp. 478ff.
[19] Pp. 496ff.
[20] P. 481.
[21] P. 481.
[22] P. 499.

TABLE I
(Single Task Method)
NUMBER OF REPORTS, CLEARNESS OF MENTAL PROCESSES AT TIME OF CHANGE, ACCURACY OF REPORT, AND KIND AND DIRECTION OF CHANGE

Report	Kind	Direction	O.	RIGHT							WRONG						
				10–9	9–8	8–7	7–6	6–5	5–4	4–3	10–9	9–8	7–8	7–6	6–5	5–4	4–3
KIND AND DIRECTION	INTENSITY	weaker	G	14	16	6	2						2				
			C	11	9	3	1							1			
			Gn	15	13	4	1	1									
		stronger	G	21	8	4	4							1		1	
			C	21	4	1	1	1	2			1		1			
			Gn	20	14	5	1	4			1	1		1			
	EXTENSITY	smaller	G	19	8	3		1					2	1	1	1	
			C	23	2	2							2	3	2	2	
			Gn	5	16	4	3				3		3	1	2	2	
		larger	G	17	10	5	2						1	1			
			C	24	4							1			4	2	
			Gn	11	7	4	1	3	1			1	1	2			
KIND	INTENSITY	weaker	G		1	1			1		1	1	2	1			
			C	1	3	1	2		3			2		1	1	1	
			Gn			1	3								1		
		stronger	G	1			1		1		1	1	3	2			
			C	1	1	2	3						1	1	1	1	
			Gn			2					1	1					
	EXTENSITY	smaller	G	1	2	1	1	1			2	3		2			
			C	2	1	1						1		1	1		
			Gn	1				1				4		2		2	
		larger	G		2							1	4	4			
			C			1	2	2					3		1		
			Gn								3	11		2			
DIRECTION	INTENSITY	weaker	G	1	1	2	1					1	1			1	
			C		2		1	1	1		1	3	1	2		3	
			Gn					1					1	3			
		stronger	G	1	1	3	2				1			1		1	
			C			1	1	1	1		1	1	2	3			
			Gn	1	1								2				
	EXTENSITY	smaller	G	2	3		2				1	2	1	1	1		
			C		1		1	1			2	1	1				
			Gn		4		2		2		1				1		
		larger	G		1	4	4					2					
			C			3		1					1	2	2		
			Gn	3	11		2										

TABLE I—(*Continued*)

Kind	Direction	O.	SUBJECTIVE							NO-REACTION						
			10–9	9–8	8–7	7–6	6–5	5–4	4–3	10–9	9–8	8–7	7–6	6–5	5–4	4–3
INTENSITY	weaker	G											1	1	1	
		C	2									1	2	2	8	
		Gn		1		1						4	3	3	3	
	stronger	G	2											1		
		C		1						1	1	1	1	1	3	
		Gn											1			
EXTENSITY	smaller	G		1										1		
		C		1							1	2	1		4	
		Gn										1	1		1	
	larger	G													1	
		C	2											2	7	
		Gn		1								2	3			

TABLE II

(Double Task Method)

NUMBER OF REPORTS, CLEARNESS OF MENTAL PROCESSES AT TIME OF CHANGE, ACCURACY OF REPORT, AND KIND AND DIRECTION OF CHANGE

Report	Kind	Direction	O.	RIGHT									WRONG								
				10-9	9-8	8-7	7-6	6-5	5-4	4-3	3-2	2-0	10-9	9-8	8-7	7-6	6-5	5-4	4-3	3-2	2-0
KIND AND DIRECTION	INTENSITY	weaker	G				2	1											5	7	
			C	1		1	1	1										1	1		
			Gn			1	1		1												
		stronger	G			1	1												3	4	
			C		2					1						1				1	
			Gn			2	4	3	3	1	1								5	4	
	EXTENSITY	smaller	G	1	1	2	1							1		1	2		4	3	
			C	5			1									1				1	
			Gn							1	1								7	2	1
		larger	G	1		1				1	1				2		1	1	5	4	
			C	2		1	1								1	1	1	1		2	1
			Gn			2											1		1	2	
KIND	INTENSITY	weaker	G					1	2	1	1						1				
			C		1			1		1				1	1	1					
			Gn				1														
		stronger	G				1	1	1	1	1							1			
			C			1								3	3	2	1				
			Gn					1		1	2										
	EXTENSITY	smaller	G		1		1			2							2				
			C	1										1		1					
			Gn				1									1	1		1		
		larger	G		1		1				1			1		2					
			C											2		2					
			Gn					1			1					3	2		1		
DIRECTION	INTENSITY	weaker	G					1									1	2	1	1	
			C		1	1	1							1			1		1		
			Gn													1					
		stronger	G						1							1	1	1	1	1	
			C		3	3	2	1							1						
			Gn														1		1	2	
	EXTENSITY	smaller	G					2						1		1			2		
			C		1		1						1								
			Gn				1	1		1						1					
		larger	G		1		2							1		1				1	
			C		2		2														
			Gn				3	2		1							1			1	

TABLE II—(*Continued*)

Kind	Direction	O.	SUBJECTIVE									NO-REACTION								
			10-9	9-8	8-7	7-6	6-5	5-4	4-3	3-2	2-0	10-9	9-8	8-7	7-6	6-5	5-4	4-3	3-2	2-0
INTENSITY	weaker	G															2		4	11
		C	1													2	1		5	18
		Gn																3	10	18
	stronger	G														2	1	3	4	9
		C				1										1	2	2	2	13
		Gn																	5	5
EXTENSITY	smaller	G																1	5	6
		C														1	1	4	5	10
		Gn																	12	9
	larger	G															1	2	6	7
		C													2		1	3	3	15
		Gn															1		10	10

TABLE III

(Single Task Method)

NUMBER OF CASES GROUPED ACCORDING TO THE KIND AND DIRECTION OF THE OBJECTIVE CHANGE; THE ACCURACY OF THE OBSERVER'S REPORTS; AND THE CLEARNESS OF THE MENTAL PROCESSES AT THE TIME OF CHANGE; WITH SUMMARY.

Kind or Direction	Report	O.	Clearness						
			10–9	9–8	8–7	7–6	6–5	5–4	4–3
Intensity	Right	G	36	25	11	7		2	
		C	34	17	7	7	1	5	
		Gn	35	27	12	5	5		
	Wrong	G	2	2	7	4		1	
		C		3	1	4	2	2	
		Gn	2	2		1	1		
	Subjective	G	2						
		C	2	1					
		Gn		1		1			
	No reaction	G				1	2	1	
		C	1	1	2	3	3	11	
		Gn			4	4	3	3	
Extensity	Right	G	37	22	9	3	2		
		C	49	7	4	2	2		
		Gn	17	23	8	4	4	1	
	Wrong	G	2	4	7	8	1	1	
		C		2	5	4	8	4	
		Gn	6	16	4	7	2	4	
	Subjective	G		1					
		C	2	1					
		Gn		1					
	No reaction	G					1	1	
		C		1	2	1	2	11	
		Gn			3	4		1	
Weaker or Smaller	Right	G	36	28	11	5	1		
		C	34	14	5	3	2	1	
		Gn	20	33	8	6	2	2	
	Wrong	G	1	3	6	2	2	2	
		C	3	4	4	6	2	5	
		Gn	4		4	4	3	2	
	Subjective	G		1					
		C	2	1					
		Gn		1		1			
	No reaction	G				1	2	1	
		C		1	3	3	2	12	
		Gn			5	4	3	4	
Larger or Stronger	Right	G	39	20	16	12			
		C	45	8	5	2	3	3	
		Gn	35	33	9	4	7	1	
	Wrong	G	1	2	1	3		2	
		C	1	3	3	6	6	2	
		Gn	1	2	3	3			
	Subjective	G	2						
		C	2	1					
		Gn		1					
	No reaction	G					1	1	
		C	1	1	1	1	3	10	
		Gn			2	4			

TABLE III—(*Continued*)

Kind or Direction	Report	O.	Clearness 10–9	9–8	8–7	7–6	6–5	5–4	4–3
Summary	Right	G	148	95	47	27	3	2	
		C	162	46	21	14	8	9	
		Gn	107	116	37	19	18	4	
	Wrong	G	6	11	21	17	3	6	
		C	4	12	13	20	18	13	
		Gn	13	20	11	15	6	6	
	Subjective	G	4	2					
		C	8	4					
		Gn		4		2			
	No reaction	G				2	6	4	
		C	2	4	8	8	10	44	
		Gn			14	16	6	8	

TABLE IV

(Double Task Method)

Number of Cases Grouped According to the Kind and Direction of the Objective Change; the Accuracy of the Observer's Reports; and the Clearness at Time of Change; with Summary.

Kind and Direction	Report	O.	Clearness 10–9	9–8	8–7	7–6	6–5	5–4	4–3	3–2	2–0
Intensity	Right	G			1	4	3	3	2	2	
		C	1	3	2	1	2		2		
		Gn			3	6	4	4	2	3	
	Wrong	G					1	1	8	11	
		C		4	4	4	1	1	1	1	
		Gn							5	4	
	Subjective	G									
		C	1		1						
		Gn									
	No reaction	G					2	3	3	8	20
		C					3	3	2	7	31
		Gn							3	15	23
Extensity	Right	G	2	3	3	3			3	2	
		C	8		1	2					
		Gn			2	1	1		1	2	
	Wrong	G		2		5	4	1	9	7	
		C		3	1	5	1	1		3	1
		Gn				4	4		10	4	1
	Subjective	G									
		C									
		Gn									
	No reaction	G						1	3	11	13
		C				2	1	2	7	8	25
		Gn						1		22	19

TABLE IV—(*Continued*)

Kind and Direction	Report	O.	Clearness 10–9	9–8	8–7	7–6	6–5	5–4	4–3	3–2	2–0
Smaller or Weaker	Right.....	G	1	1	2	3	4				
		C	6	2	2	4	1				
		Gn			1	2	1	1	2	1	
	Wrong.....	G		2		2	3	2	12	11	
		C	1	1		1	1	1	2	1	
		Gn				2			7	2	1
	Subjective....	G									
		C	1								
		Gn									
	No reaction...	G						2	1	9	17
		C					3	2	4	10	28
		Gn							3	22	27
Larger or Stronger	Right.....	G	1	1	2	3		1	1	1	
		C	2	7	4	5	1		1		
		Gn			4	7	5	3	2	1	
	Wrong.....	G		1		4	1	2	9	10	
		C			2	2	1	1		3	1
		Gn					3		7	9	
	Subjective....	G									
		C			1						
		Gn									
	No reaction...	G					2	2	5	10	16
		C				2	1	3	5	5	28
		Gn						1		15	15
Summary	Right.....	G	4	5	8	13	7	4	6	5	
		C	17	12	9	12	4		3		
		Gn			10	16	11	8	7	7	
	Wrong.....	G		5		11	9	6	38	39	
		C	1	8	7	12	4	4	3	8	2
		Gn				6	7		29	19	2
	Subjective....	G									
		C	2		2						
		Gn									
	No reaction...	G					4	8	12	38	66
		C				4	8	10	18	30	112
		Gn						2	6	74	84

TABLE V

(Single Task Method)

Weighted Summaries

O.	Reports	Clearness 100–90	90–80	80–70	70–60	60–50	50–40
G	Total right.....	148.0	95.0	47.0	27.0	3.0	2.0
	Total wrong.....	10.0	13.0	21.0	19.5	10.5	11.0
C	Total right.....	162.0	46.0	21.0	14.0	8.0	9.0
	Total wrong.....	14.5	21.0	23.0	30.0	30.5	68.0
Gn	Total right.....	107.0	116.0	37.0	17.0	18.0	4.0
	Total wrong.....	13.0	24.0	28.5	37.0	13.5	16.0

TABLE VI

(Double Task Method)

WEIGHTED SUMMARIES

O.	Reports	CLEARNESS								
		100-90	90-80	80-70	70-60	60-50	50-40	40-30	30-20	20-00
G	Total right.....	4.0	5.0	8.0	13.0	7.0	4.0	6.0	5.0	
	Total wrong. ...		5.0		16.0	15.0	22.0	53.0	86.5	82.5
C	Total right.....	17.0	12.0	9.0	12.0	4.0		3.0		
	Total wrong. ...	3.0	8.0	9.0	17.0	14.5	16.5	25.5	45.5	142.5
Gn	Total right.....			10.0	16.0	11.0	8.0	7.0	7.0	
	Total wrong. ...				6.0	7.0	2.5	36.5	111.5	107.0

SPECIAL POINTS

(1) The *relation between the observers' reports and the kind and direction of objective change* is shown in Tables VII and VIII, which correspond respectively to Tables IV[23] and XIII[24] of the first study. Table VII shows for all observers that more intensive than extensive changes are correct, that intensive changes are more attention-compelling than extensive, and that changes to a larger and stronger cutaneous stimulus are more compelling than changes to a smaller and weaker. Table VIII does not show a uniform tendency; the work in the Double Task Method was probably not influenced by anything else than fluctuation of attention.

(2) The *promptness of voluntary action* as a measure of attention[25] is shown, irrespectively of the correctness of the judgments, in Tables IX and X (analogous to Tables V[26] and XIV[27] of the first paper).

TABLE VII

(Single Task Method)

RELATION BETWEEN THE OBSERVER'S REPORTS AND THE KIND AND DIRECTION OF THE OBJECTIVE CHANGES

O.	KIND								DIRECTION							
	INTENSITY				EXTENSITY				DOWN				UP			
	R.	W.	S.	N.	R.	W.	S.	N.	R.	W.	S.	N.	R.	W.	S.	N.
G	81	16	2	4	73	23	1	2	81	16	1	4	87	9	2	2
C	71	12	3	21	64	23	3	17	59	24	3	21	66	21	3	17
Gn	84	6	2	14	57	39	1	8	71	17	2	16	89	9	1	6
Total	236	34	7	39	194	85	5	27	211	57	6	41	242	39	6	25

Down, smaller or weaker. Up, larger or stronger. R., right. W., wrong. S., subjective. N., no-reaction.

[23] P. 482. [24] P. 501.

[25] *Cf.* H. Woodrow, *Psychol. Rev. Monog. Suppl.*, XVII, no. 5, who asserts "that reaction time may vary without corresponding variation in attention" (p. 139), yet admits that "the absolute increase in reaction time produced by the use of unfavorable intervals as a distractor varies inversely as the degree of attention" (pp. 12, 98).

[26] P. 484. [27] P. 501.

TABLE VIII

(Double Task Method)

RELATION BETWEEN THE OBSERVER'S REPORTS AND THE KIND AND DIRECTION OF THE OBJECTIVE CHANGES

O.	KIND								DIRECTION							
	INTENSITY				EXTENSITY				DOWN				UP			
	R.	W.	S.	N.	R.	W.	S.	N.	R.	W.	S.	N.	R.	W.	S.	N.
G	15	21	..	36	16	28	..	28	11	32	..	29	10	27	..	35
C	11	16	2	46	11	15	..	45	15	8	1	47	20	10	1	44
Gn	22	9	..	41	7	23	..	42	8	12	..	52	22	19	..	31
Total	48	46	2	123	34	66	..	115	34	52	1	128	52	56	1	110

Down, smaller or weaker. Up, larger or stronger. R., right. W., wrong. S., subjective. N., no-reaction.

TABLE IX

(Single Task Method)

AVERAGE REACTION-TIME OF THE OBSERVER'S REPORT IN SECONDS AT THE DIFFERENT LEVELS OF ATTENTION

O.		CLEARNESS								
		100–90	90–80	80–70	70–60	60–50	50–40	40–30	30–20	20–00
G	Av. R.	1.19	1.18	1.34	1.55	1.93				
	m. v.	.34	.32	.35	.45	.43				
	No.	73	49	23	21	3				
C	Av. R.	1.20	1.47	1.66	1.51	1.80	2.30			
	m. v.	.38	.45	.52	.50	.73	.82			
	No.	91	13	16	13	7	9			
Gn	Av. R.	1.04	.94	1.20	1.25	1.09	1.29			
	m. v.	.32	.28	.51	.44	.20	.25			
	No.	41	71	14	12	10	7			

Av. R. average reaction time. m. v., mean variation. No., number of cases.

TABLE X

(Double Task Method)

AVERAGE REACTION-TIME OF THE OBSERVER'S REPORT IN SECONDS, AT THE DIFFERENT LEVELS OF ATTENTION

O.		CLEARNESS								
		100–90	90–80	80–70	70–60	60–50	50–40	40–30	30–20	20–00
G	Av. R.	0.70	0.95	0.60	0.79	0.95	0.87	1.68	1.50	
	m. v.	.30	.40	.20	.38	.31	.27	.92	.75	
	No.	2	6	4	13	6	7	18	17	
C	Av. R.	1.32	1.30	1.42	1.80	1.47		.80	2.57	1.90
	m. v.	.66	.40	.78	.82	.96		.00	1.37	.00
	No.	10	5	8	7	4		2	4	1
Gn	Av. R.			1.02	0.98	0.97	1.17	1.18	0.99	1.40
	m. v.			.44	.30	.19	.41	.37	.11	.00
	No.			5	12	8	4	15	12	1

Av. R., average reaction time. m. v., mean variation. No., number of cases.

The coefficients of correlation (figured by Pearson's 'product moments' method) and the probable error are, for the Single Task Method:

O.	Correlation	P.E.
G	—0.98	0.011
C	—0.64	0.162
Gn	—0.70	0.140

and for the Double Task Method:

O.	Correlation[28]	P.E.
G	—0.74	0.101
C	—0.91	0.047
Gn	—0.33	0.247

These results corroborate those which we obtained in our first paper, and lead us to the conclusion that reactions of this sort are reliable indices of attention.

(3) In our earlier study we pointed out that the *mean variation* has frequently been used as a measure of attention, and our results at that time tended to confirm such a view. The results of the present study, however, are not conclusive. The correlation between the mean variations and the degrees of clearness, the data of which appear in Tables IX and X, is (Pearson's method) for the Single Task Method:

O.	Correlation	P.E.
G	—0.85	0.063
C	—0.94	0.023
Gn	+0.30	0.239

and for the Double Task Method:

O.	Correlation[29]	P.E.
G	—0.65	0.115
C	—0.83	0.064
Gn	+0.29	0.242

The figures for G and C corroborate our previous findings,[30] whereas Gn's results are contradictory. The difference may be due to the different interpretation that Gn placed upon his instructions, and also to the fact that he frequently reported change without being able to tell the kind or direction.[31] As the delayed reactions show, he did not interpret the directions to mean "react as quickly as possible", but merely "react in order to report." The reactions might therefore be made at his convenience. It is possible that, in the changes which were clear, he sometimes delayed his replies until he was absolutely certain both as to Kind and as to Direction, while at other times he reacted as soon as

[28] In the computation of these correlations the data under the 7th and 9th rubrics for C, and the 9th rubric for Gn, were omitted because they represented too few cases: 2, 1, and 1 cases respectively.

[29] See preceding foot-note.

[30] Pp. 485, 502.

[31] Such reports were counted as wrong as to both Kind and Direction, and two points were added to the wrong replies in the weighted results. A half point was thereby credited to the observer; for, had he not noted the fact of change, 2.5 points would have been added to the side of 'wrong.'

the change was perceived (this would account for the small reaction times and the large mean variation in the high degrees of clearness); and that, in the changes which were obscure, he always reacted as soon as he became aware of the changes, because, no matter how long he delayed, they were too obscure for him to tell kind or direction (this would account for the long reaction times and the small variations of the low degrees of clearness). We cannot offer more than this general and hypothetical explanation of the discrepancy.

(4) The *relation of the reaction times to the Kind and Direction of the objective change* appears for the two methods in Tables XI and XII, which correspond to Tables VI[32] and XV[33] of the first study.

TABLE XI

(Single Task Method)

RELATION BETWEEN THE OBSERVER'S REACTION TIME IN SECONDS AND THE KIND AND DIRECTION OF THE OBJECTIVE CHANGE

O.	KIND						DIRECTION					
	INTENSITY			EXTENSITY			DOWN			UP		
	Av.	m.v.	No.	Av.	m.v.	No.	Av.	m.v.	No.	Av.	m.v.	No.
G	1.28	.40	82	1.25	.32	87	1.29	.38	82	1.24	.39	87
C	1.54	.55	73	1.27	.43	76	1.42	.48	76	1.39	.52	73
Gn	1.06	.38	71	1.02	.27	84	1.09	.37	73	.98	.33	82

Av., average reaction time. m.v., mean variation. No., number.

TABLE XII

(Double Task Method)

RELATION BETWEEN THE OBSERVER'S REACTION-TIME IN SECONDS AND THE KIND AND DIRECTION OF THE OBJECTIVE CHANGE

O.	KIND						DIRECTION					
	INTENSITY			EXTENSITY			DOWN			UP		
	Av.	m.v.	No.	Av.	m.v.	No.	Av.	m.v.	No.	Av.	m.v.	No.
G	1.31	.78	34	1.05	.47	39	1.21	.68	40	1.14	.57	33
C	1.66	.78	24	1.66	.90	17	1.55	.89	20	1.77	.89	21
Gn	1.08	.29	30	.98	.19	27	1.07	.27	18	1.02	.22	39

Av., average reaction time. m.v., mean variation. No., number.

Tables II and IV show that there is a positive correlation between variation in attention and accuracy of work, regardless of the kind and direction of the objective change. We have seen, nevertheless, from Tables VII and VIII, that intensive changes are more compelling than extensive, and that changes to a greater are more compelling than changes to a smaller. This relation is only partially confirmed by the reaction times, as is shown by Tables XI and XII above. If we assume that the most compelling changes give the shortest reaction time, then we must say that the reaction times show that extensive changes and

[32] P. 486. [33] P. 502.

changes to the greater are the most compelling, since the average reaction times and mean variations are larger for intensity than for extensity and larger for changes to a smaller than to a greater. The relation is not absolute, for C in the Double Task Method has the same average reaction time for both the intensive and extensive changes, and a shorter reaction for the changes to a smaller than to a greater. The difference is, however, in no case great and shows once more that the work in these experiments was not influenced by anything else than fluctuation of attention.

(5) A comparison of Tables VII and XI with Tables VIII and XII shows that there is a close correlation between the *reaction time and the accuracy of report.* This relation is more clearly shown in Tables XIII and XIV (*cf.*, in the first paper, Tables VII[34] and XVI[35] respectively), in which the reaction times are compared directly with the accuracy of the reports. The results agree with those previously reported.

TABLE XIII

(Single Task Method)

THE REACTION-TIME IN SECONDS AND THE MEAN VARIATION OF THE RIGHT, HALF-RIGHT, AND WRONG REPORTS

Observer	RIGHT			HALF-RIGHT			WRONG		
	Av.	m.v.	No.	Av.	m.v.	No.	Av.	m.v.	No.
G	1.27	.33	127	1.33	.35	33	1.44	.15	9
C	1.38	.41	111	1.50	.45	26	1.84	.70	12
Gn	.97	.28	108	1.21	.49	36	1.26	.37	11

Av., average reaction-time. m.v., mean variation. No., number.

TABLE XIV

(Double Task Method)

THE REACTION-TIME IN SECONDS AND THE MEAN VARIATION OF THE RIGHT, HALF-RIGHT, AND WRONG REPORTS

Observer	RIGHT			HALF-RIGHT			WRONG		
	Av.	m.v.	No.	Av.	m.v.	No.	Av.	m.v.	No.
G	0.71	.19	15	1.18	.58	40	1.62	1.02	18
C	1.36	.58	10	1.48	.76	24	2.33	1.08	7
Gn	0.98	.30	20	1.05	.23	13	1.06	.19	24

Av., average reaction-time. m.v., mean variation. No., number.

(6) The *effect of the distractors* used in the Single Task Method is shown in Table XV (with which *cf.* Table VIII of the other study[36]).

[34] P. 486. [35] P. 503.

[36] P. 487, with which *cf.* p. 472.

TABLE XV

(Single Task Method)

THE AVERAGE CLEARNESS OF THE CUTANEOUS SENSATIONS AS AFFECTED BY THE DISTRACTORS

O.		DISTRACTOR						
		0	1	2	3	4	5	6
G	Av. C.	85.5	81.6	84.3	83.8	82.9	76.3	73.5
	m.v.	4.1	9.2	7.4	7.2	5.8	12.2	13.0
	No.	30	22	31	33	31	18	34
C	Av. C.	87.2	75.0	84.0	70.2	85.0	77.1	65.0
	m.v.	14.3	22.3	16.4	22.0	13.2	20.4	27.1
	No.	36	22	31	36	31	18	34
Gn	Av. C.	94.7	70.0	78.8	71.1	85.3	77.6	82.5
	m.v.	1.7	14.8	7.2	13.3	7.0	6.8	8.7
	No.	36	22	31	36	31	18	34

Av. C., average clearness of cutaneous sensations. m.v., mean variation. No., number of cases. 0, normal conditions. 1, flicker. 2, buzzer. 3, bell. 4, metronome. 5, flicker and buzzer. 6, phonograph.

The table shows that the distractors were not especially effective, that there was a wide variation from day to day in their effectiveness, and that there was a great difference in their effect upon the different observers. We have already discussed the factors upon which these points depend in our previous paper.[37] The last point is exhibited in Table XVI (corresponding to Table IX of the first paper [38]).

TABLE XVI

(Single Task Method)

THE ORDER OF THE EFFECTIVENESS OF THE DISTRACTORS FROM LEAST TO GREATEST AS DETERMINED BY THE AVERAGE CLEARNESS OF THE CUTANEOUS SENSATIONS

Observer	ORDER						
	1	2	3	4	5	6	7
G.	0	2	3	4	1	5	6
C.	0	4	2	5	1	3	6
Gn.	0	4	6	2	5	3	1

0, normal. 1, flicker. 2, buzzer. 3, bell. 4, metronome. 5, flicker and buzzer. 6, phonograph.

(7) The *effect of the secondary tasks upon attention* is shown in Table XVII, which corresponds to Table XVII of our earlier work.[39]

[37] Pp. 489f. [38] P. 488. [39] P. 504.

TABLE XVII

(Double Task Method)

THE AVERAGE CLEARNESS OF THE CUTANEOUS SENSATIONS AS AFFECTED BY THE DIRECTION OF ATTENTION ON THE PRIMARY OR SECONDARY TASK

Observer		ATTENTION DIRECTED TO		
		0	1	2
G	Av. C	92.0	22.5	44.3
	m.v	6.30	15.19	25.47
	No	36	75	69
	Av. R	1.02	1.32	1.11
C	Av. C	95.0	32.8	23.9
	m.v	4.30	15.57	19.57
	No	36	75	69
	Av. R	1.10	1.57	1.69
Gn	Av. C	95.0	18.4	21.2
	m.v	3.33	8.56	11.45
	No	36	75	69
	Av. R	.78	1.12	.90

Av. C., average clearness of cutaneous sensations. m.v., mean variation. No., number of cases. 0, attention directed to cutaneous sensations. 1, attention directed to adding processes. 2, attention directed to subtracting processes. Av. R., average reaction time for experiments under each rubic.

The results are like those of the previous paper. They show the effect of the division of attention. In the normal or control experiments, the average clearness of the cutaneous sensations is uniformly higher, the mean variation is uniformly smaller, and the reaction time is uniformly shorter than is the case in the Double Task experiments.

(8) Table XVIII shows the *relation between the character and quality of the work performed, and attention* as introspectively estimated in terms of attributive clearness (Table XVIII of the first article [40]).

TABLE XVIII

(Double Task Method)

COMPARISON BETWEEN THE AVERAGE CLEARNESS OF THE MENTAL PROCESSES INVOLVED IN CONTINUOUS ADDING; IN CONTINUOUS SUBTRACTING; AND THE ACCURACY OF THE WORK PERFORMED

O.	Report	MENTAL PROCESS											
		ADDING—CLEARNESS						SUBTRACTING—CLEARNESS					
		10-9	9-8	8-7	7-6	6-5	5-4	10-9	9-8	8-7	7-6	6-5	5-4
G	Correct	2						4	1				
	Nearly correct	4	2	2				6	1				
	Failure	3	3	4	3	2		1	3		2	5	
	No. cases	9	5	6	3	2		11	5		2	5	
C	Correct	2											
	Nearly correct	4	3	1	1	1		4	2				
	Failure	4	1	5		3		4	2	3	2	6	
	No. cases	10	4	6	1	4		8	4	3	2	6	
Gn	Correct	1	1										
	Nearly correct	2	3	1				1	1				
	Failure	3	10	1	2	1		4	7	7	2	1	
	No. cases	6	14	2	2	1		5	8	7	2	1	

[40] P. 504.

The results are those that we have learned to expect; more correct answers and fewer failures were returned during the higher degrees of clearness than in the lower. We have evidence once more, therefore, that introspectively distinguished variations of clearness are closely paralleled by corresponding differences in the accuracy of the work performed.

(9) In working over the data for information concerning the *number of levels* of attentive consciousness, we have included the introspections of L. B. Hoisington, given during the preliminary training and practice periods. H's work was cut short by mid-year graduation, and his results were for that reason not reported in the other connections. He gave in the preliminary training and practice periods 189 reports; which, with those of the other observers, make up a total of 1175.

The observers reported without exception the dual division of consciousness; that is to say, a clear focus and a vague background, which varied reciprocally.[41] The introspective values for the upper and lower levels of clearness did not in every case total 100, but the discrepancy was never very large. It was never more than five degrees the one way or the other, and more often smaller than larger.

Summary

Our conclusions, based upon the present work with extent and intensity of cutaneous sensation, substantiate the conclusions which we have printed for the work with pitch and intensity of auditory sensation.[42] The reader is referred to the previous Summary.

We find again that the Double Task or division method gives a greater variation in the range of attention than does the Single Task or distraction method.[43] Thus we may conclude that the Double Task method is the more effective.

Concerning the relation of intensive to extensive changes, we may now conclude that intensive changes and changes to a greater intensity or extent are slightly more compelling than are extensive changes and changes to a smaller intensity or extent.

[41] *Op. cit.*, p. 506. [42] *Op. cit.*, 507. [43] *Op. cit.*, 490.